Liboreiro, P. R., Fernández, R., & García, C. (2021). The drivers of deindustrialization in advanced economies: A hierarchical structural decomposition analysis. *Structural Change and Economic Dynamics*, *58*, 138-152. https://doi.org/10.1016/j.strueco.2021.04.009

THE DRIVERS OF DEINDUSTRIALIZATION IN ADVANCED ECONOMIES: A HIERARCHICAL STRUCTURAL DECOMPOSITION ANALYSIS

ABSTRACT

The participation of manufacturing in the GVA of many advanced economies is continuously decreasing. The purpose of this work is to contribute to the dialogue around the drivers of such trend. In order to do so, we use input-output analysis for decomposing the variation in the manufacturing share as the sum of the effects of the variation of various possible drivers of deindustrialization: prices, domestic demand, technology and external trade; and we calculate these effects through a dynamic-hierarchical structural decomposition analysis. As a result of the analysis, we identify certain regularities: (a) variations in prices and domestic demand are the two most important factors explaining deindustrialization; (b) a process of substituting domestic production by imports also contributes to deindustrialization; (c) exports make a positive contribution to the participation of manufactures in the GVA but, after the 2008 crisis, this contribution does not offset the negative contribution of substitution by imports.

Keywords: Deindustrialization; Structural change; Input-output; HSDA.

1. INTRODUCTION

As numerous studies have found, the participation of manufactures in total employment of the most industrialized economies has been decreasing continuously (Felipe *et al*., 2019). For several decades, declines in manufacturing employment have been accompanied by setbacks in manufacturing Gross Value Added (GVA). According to data from the World Input Output Database (Releases 13 and 16, see Table 1), which serve as the basis for this work, the contribution of manufacturing to GVA in the 15 largest economies in the OECD fell on average by just over four percentage points (and by five, if we exclude South Korea and Taiwan) across twenty years (1995-2014), ultimately concluding this period at below 15%.[1]

According to the academic literature, this loss of participation by manufacturing in the GVA can be explained basically through four trends: decreases in relative prices, decreases in relative demand, technological changes favorable to services as intermediate inputs, and an increasing propensity to import manufactured products. The purpose of this work is to contribute to the dialogue around the greater or lesser relevance of these trends by providing additional empirical information organized in a way that is consistent with these debates.

To achieve this purpose, we use input-output analysis to structurally decompose the fall in the participation of manufactures in the GVA into the effects of the aforementioned trends. Once we have formulated a computable decomposition, we apply what is known as a dynamic "hierarchical structural decomposition analysis" (HSDA). More concretely, we apply a dynamic HSDA to a first-order approximation to Leontief's "open model", in order to quantify the effects of changes in a set of factors, considered approximately independent, to the variation in the participation of manufactures in GVA. Our methodological contribution is twofold. First, we apply the HSDA to the study of changes in the

[1] We use data from the World Input Output Database (WIOD) throughout this work. Although data on the GVA for manufacturing from this source do not fully coincide with data from other sources (*e.g*. the World Bank), we have opted for the WIOD because it is from this database that data for the decomposition into drivers of the fall of GVA in manufacturing will be extracted.

participation of sectors in national income, instead of to the analysis of changes in aggregates in absolute terms. Second, by means of a first-order approximation to Leontief's "open model", we are able to distinguish in a simple way between real effects (derived from variations in factors considered at constant prices) and nominal effects (which result from changes in relative prices). As a result of both innovations, we decompose the variation in the participation of manufactures in GVA into the effects of the changes of eight factors: a vector of prices, a vector of taxes less subsidies per unit of product, a matrix of coefficients of total intermediate consumption at constant prices, a matrix of coefficients of imported intermediate consumption at constant prices, a vector of international transport margins per unit of product, a vector of coverage rates for final goods and services, a vector of domestic demand, and a vector of export demand.

In order to be able to contribute to the debate on the drivers of deindustrialization, we group the eight effects derived from the corresponding variations of the eight vectors and matrices into four effects: a "price effect", a "domestic demand effect", a "technology effect", and an "external trade effect", the latter being further broken down into an "import effect" and an "export effect". These effects are completed with a residual factor that includes the effect of non-first-order terms, as well as the effect attributed to the change in the vector of taxes less subsidies per unit of product. This grouping of effects has the virtue of offering primary quantitative information on the contribution of each of the drivers of deindustrialization that appear in the literature, based on one single source (the World Input Output Database or WIOD). Unlike alternative approaches, this allows to jointly observe a relatively large number of factors, for a relatively large and heterogeneous number of countries, over a relatively long period of time.

For the purposes of our study, we initially took as a reference the 15 largest industrialized economies, although after a first exploration of the data we excluded Taiwan and South Korea (hereafter, Korea) from the analysis.[2] Data were obtained from the WIOD, which offers two series: one (Release 2013 or R13) that provides data from 35 sectors (ISIC Rev. 3) and 40 countries for the period 1995-2009; and another (Release 2016 or R16) that provides data from 56 sectors (ISIC Rev.4) and 43 countries for the period 2000-2014. The data consisted of national input-output tables for the countries analyzed, and calculations were undertaken for both data series (removing 2009 from the first series in order to limit analysis to pre-crisis years).

This analysis, though does not allow, strictly speaking, for contrasting any of the hypotheses formulated in the literature on the drivers of deindustrialization, it does have the virtue of identifying certain regularities that have been more or less common to the phenomenon of deindustrialization. These regularities are: (a) variations in prices and in domestic demand are the two most important factors in explaining the variation in the participation of manufactures in the GVA; (b) deindustrialization is explained not only by the two mentioned factors, but also by a process of substitution of domestic production by imported products; and (c) external demand makes a clearly positive contribution to the participation of manufactures in the GVA, but, after the 2008 crisis, this contribution does not offset the negative contribution of substitution by imports. Considering the debates on the literature, probably the most significant result of the analysis is that external trade as a whole plays a determining role in the

[2] We initially selected the fifteen largest mature economies; however, in view of the data presented in Table 1, we chose to exclude Korea and Taiwan from the analysis of average results (in any case, disaggregated results for all countries, including Korea and Taiwan, are given in Tables 2 and 3). Given that our object of study is deindustrialization (a downward trend in the share of manufacturing in GVA), we exclude from the calculation of averages those countries that displayed marked upward trends in manufacturing shares – Korea's manufacturing increased in both sub-periods under study and Taiwan's since the 2008 crisis. To be true, Germany does not deindustrialize either, but the upward variation of the share in manufacturing is, in both periods, negligible. Furthermore, its manufacturing share remains about 8 percentage points above the 13-cuntries average, whereas Korea's and Taiwan's exceed it by more than 15 percentage points.

variations suffered by the participation of manufactures in the GVA, in contrast to the importance traditionally given to non-trade factors.

The structure of this paper is as follows. First (Section 2), we give a synthesis of those theoretical and empirical contributions found in the literature that we consider most relevant to the explanation of deindustrialization. Second (Section 3), we describe the basic characteristics of the method used to estimate the data. Third (Section 4), our results are presented and discussed. Finally (Section 5), the most relevant conclusions are highlighted.

Table 1. Participation of manufacturing in the GVA (in %) for 15 OECD economies, 1995-2014

	Release 13 (1995-2008)				Release 16 (2008-2014)		Variation (in percentage points)	
	1995	2000	2005	2008	2008 (1)	2014	1995-08	2008-14
Australia	14.6	12.7	11.0	10.3	9.1	6.8	-4.24	-2.30
Austria	19.6	20.6	19.6	19.5	19.6	18.4	-0.17	-1.15
Belgium	20.3	19.3	17.2	15.4	15.9	13.8	-4.93	-2.10
Canada	18.4	19.3	15.1	13.7	11.9	11.1	-4.73	-0.81
France	14.3	16.1	13.3	12.0	12.1	11.2	-2.35	-0.90
Germany	22.7	23.0	22.7	22.7	22.5	22.6	0.03	0.12
Italy	22.4	21.1	18.7	18.3	17.1	15.4	-4.11	-1.67
Japan	22.6	21.2	20.6	19.5	20.1	18.9	-3.12	-1.17
Korea	27.2	28.6	27.8	28.2	28.6	30.3	0.99	1.69
Netherlands	17.5	15.6	14.3	13.8	12.9	12.1	-3.73	-0.86
Spain	19.2	18.6	15.8	14.5	14.5	13.2	-4.71	-1.26
Sweden	22.4	22.0	19.9	17.7	19.1	16.4	-4.71	-2.71
Taiwan	26.7	24.7	24.1	22.6	28.2	30.7	-4.09	2.49
UK	21.0	17.3	13.1	11.4	10.7	10.6	-9.62	-0.04
USA	15.5	14.3	12.6	11.6	12.5	12.2	-3.95	-0.24
OCDE-15 Avg	20.3	19.6	17.7	16.7	17.0	16.3	-3.56	-0.73
OCDE-13 Avg (2)	19.3	18.5	16.5	15.4	15.2	14.1	-3.85	-1.18

Source: World Input Output Database (WIOD).

[1] The R16 series begins in 2000 and presents differences in 2008 figures with respect to the same year of the previous series (R13), which begins in 1995 and ends in 2009.
[2] Excludes Taiwan and Korea.

2. DEINDUSTRIALIZATION DRIVERS IN THEORETICAL AND EMPIRICAL LITERATURE

As indicated in the Section 1, the objective of this research is to carry out a decomposition analysis of the variation in the participation of manufacturing in the GVA, in the factors that determine said variation, based on the data provided by the input-output accounting; and thus to provide additional evidence arranged according to topics presented by the literature. These topics refer to hypotheses posed around the causes of deindustrialization in developed countries, which are essentially four: (a) disparate trends in relative prices; (b) changes in the composition of demand; (c) changes in the composition of the inputs of production techniques; and d) changes in the pattern of international specialization. Here we briefly summarize the main sources of these topics.

First, the explanation of variations in the participation of manufactures in the GVA due to changes in relative prices derives from multiple references in the theoretical literature, most of which refer to seminal works by Baumol (1967, 1985) on the trend toward concentration of employment into the services sector, and the consequent slowdown in the growth of labor productivity. In these works, Baumol argues that if productivity growth in services tends to be less than growth in manufacturing, and as long as wages grow equally in the two sectors, costs in services will grow more rapidly than costs in manufacturing. From this greater increase in services unit costs, it follows that the prices of services will grow more rapidly than the prices of industrial products, so that as demand increases (given a lower price elasticity of service demand) the share of manufacturing will tend to decrease, not only in terms of employment but also in terms of gross value added (at current prices).

This Baumolian thesis, known as the "cost disease" (Nordhaus, 2008), has received a great deal of attention in the recent literature. Ngai and Pissarides (2007) appear to confirm that the structural change observed is the result of changes in relative prices that arise as a consequence of productivity differentials between sectors. Almon and Tang (2011) and Herrendorf *et al*. (2015) reach similar conclusions, taking into account the sectoral differences in technology and productivity.

Other works raise doubts in this regard. Buera and Kaboski (2009) indicate that data on the American economy show divergence in the evolution of the participation of manufacturing in terms of output and employment that cannot be explained by only considering the existence of sectoral biases in the behavior of productivity and prices.[3] Elsewhere, Duernecker *et al*. (2017) consider that the Baumol effect will tend to become less and less pronounced.[4] Other contributions question whether the productivity of manufacturing will always be inevitably higher than that of services (Duarte and Restuccia, 2017; Inklaar and Timmer, 2014; Jorgenson and Timmer, 2011), and some go so far as to affirm that the "cost disease" has ceased to exist (Triplett and Bosworth, 2003). Finally, Schreyer (2001) and others recall that productivity differences are often the result of deficiencies in growth accounting, thereby frustrating conclusive results on the influence of the Baumol effect on changes in the production structure.[5]

Second, in regard to the hypothesis stating that deindustrialization is attributable to changes in composition of domestic demand, and based on prior statements by Engel, Clark (1951) suggested the existence of a structural tendency toward decreases in manufacturing in the GVA as a consequence of the lower demand-income elasticity of manufactured products compared to that of services. The progressive incorporation of women into the labor market and the growing demand for non-market (public) services begun in the 1950s would contribute in the opinion of Gadrey (2003) toward reinforcing this dynamic of change. More recently, Comín *et al*. (2017) have provided new evidence regarding the non-homothetic nature of preferences, reinforcing the thesis that the "hierarchy of needs" is the main determinant of structural change in the most industrialized economies.

These conclusions are not shared by Buera and Kaboski (2009), who when integrating uneven productivity growth and non-homothetic preferences in a standard growth model find difficulties in explaining structural change based solely on changes in preferences. Herrendorf *et al*. (2013), while confirming the importance of the income effect on changes in the composition of final demand, observe a greater incidence of relative prices when sectoral changes are analyzed from the perspective of added value. For his part, Iscan (2010) attributes the structural change to a combination of the Engel and Baumol effects.

---

[3] Buera and Kaboski (2009) suggest that the unequal endowment of human capital could help to explain these discrepancies. Duarte and Restuccia (2007) explore other types of sector specificities as possible explanatory factors for changes in the participation in total added value.

[4] For Baumol, the progressive advance of the services sector leads to an asymptotic result for productivity growth in the economy as a whole, which gradually slows until it equals the rate of productivity growth presented by the services sector (Nordhaus, 2008; Rial, 2019).

[5] The greater growth of productivity in manufacturing is supported by the existence of increasing returns to scale, as confirmed in numerous works (Angeriz *et al*., 2008; Kaldor, 1966; McCombie, 1982; Millemaci and Ofria, 2014); however, certain studies suggest that increasing returns to scale are likewise relevant in certain service activities (Di Meglio *et al*., 2018; Pieper, 2003).

Third, the hypothesis that highlights changes in the composition of inputs of production techniques as a vector of deindustrialization has received less attention in the recent literature. This line of explanation admits the possibility of lower growth in the GVA of manufactures in relation to services, without the need to assume changes in relative prices or sectoral biases in the behavior of final demand. Here it is enough to concede the existence of continuous changes in production techniques, with consequent alteration of the technical coefficients of the input-output matrix. If these technical changes lead to an increase in the number of intermediate services and/or a reduction in the number of manufactured products required per unit of output, then the GVA generated by manufacturing would grow at a slower rate than that of services (assuming that everything else remains the same).

These changes in technical coefficients may have their origin in technology as well as in the business organization of industrial processes. When the origin of change is organizational (as a consequence, for example, of the outsourcing of services linked to manufacturing production), variations in the GVA would be only apparent. Tregenna (2014) and Djellal and Gallouj (2008) explain such problems of measurement in detail. However, evidence exists that the strong growth experienced by intermediate services has not been due to purely statistical factors (as a consequence, for example, of the outsourcing processes of companies). This is evidenced in studies by Crozet and Milet (2017), Kelle (2013), and Cuadrado-Roura and Maroto (2016) on the respective manufacturing industries of France, Germany, and Spain. Berlingeri and Marcolin (2018) and Baldwin *et al*. (2015) show the importance of the advance of servitization in production destined for exports. Beyond the causes of this phenomenon and the identification of a certain recent setback (Kowalkowski *et al*., 2017), all these authors agree in pointing out that servitization may lead to a quantitative decrease of manufacturing in the GVA, but also to a qualitative strengthening of the same.

Finally, there are many more works suggesting that changes in the pattern of international specialization as a result of globalization constitutes a determining factor in the explanation of deindustrialization by the most developed economies (*e.g*. Rowthorn and Ramaswamy, 1999; Van Neuss, 2018). However, there seems to be no consensus around the net effect of exports and imports on the participation of manufactures in the GVA.

Following Krugman's hypothesis of deindustrialization (Krugman, 1996), globalization would exert a negative influence on the participation of manufacturing in the GVA via prices and/or quantity of imports, principally due to two self-reinforcing factors: increasing exporter competition from the new industrial countries, and the transfer by local companies of certain stages (or even complete lines) of production of industrial goods to lower-wage countries. Following Matsuyama (2009, 2017), this structural change "against" manufacturing due to globalization is not driven by supply but demand induced patterns caused by the Engel's law.

Still, Matsuyama does not reject the idea that the advance of globalization might also exert a positive influence, insofar as it offers the industrial sectors in more mature economies the possibility of taking advantage of an expanding world market, as a contrast to the decline experienced in their respective domestic markets. More specifically, if international demand grows faster than domestic demand (which is common in mature economies), then total demand for manufacturing could grow faster than demand for services, even assuming a greater elasticity of demand for services for any income level, since the export propensity of manufactured goods is usually significantly higher than that of services.

As mentioned in the Section 1, the method for decomposition employed in this work is not an exercise in contrasting the above hypotheses; rather, it offers the possibility of quantifying the contribution of each of the drivers highlighted by these hypotheses to the deindustrialization processes affecting the most developed economies. Other methodologies to the same purpose – quantifying the importance of the different explanatory factors of deindustrialization – have certainly been used before this.

Basically, four distinct methods can be identified: (a) the development and calibration of a multisectoral version of the standard growth model, mainly in order to estimate the importance of the evolution of total factor productivity and/or households (Buera and Kaboski, 2009; Herrendorf *et al*., 2015; Comín *et al*., 2017; Álvarez-Cuadrado *et al*., 2017); (b) the econometric specification, usually by means of regression with panel data, of some relationship deduced from some (standard or non-standard) multisectoral model in which employment or the manufacturing added value are considered as a function of other not necessarily exogenous variables (Rowthorn and Ramaswamy, 1999; Boulhol and Fontagné, 2006); (c) an analysis of the decomposition of aggregate indices from some relationship theoretically deduced from some (standard or non-standard) multisectoral model in order to attribute the registered variation to each of the components; and (d) a structural decomposition analysis based on input-output analysis (typically, the Leontief open model) with the aim of attributing the registered variation to each of the components (Kucera and Milberg, 2003; Savona and Lorentz, 2006).

The methodology followed in this work is similar to the latter method, insofar we formulate a structural decomposition based on input-output analysis; but then we calculate the contribution to deindustrialization of each component with HSDA. The HSDA method reaches its final form in Chen and Wu (2008) and Koller and Stehrer (2009, 2010), works that followed the contributions of Liu *et al*. (1992), Rose and Casler (1996), and Dietzenbacher and Los (1998), among others. We contribute two novelties to the use of HSDA for the analysis of deindustrialization. First, we develop a way in which the HSDA can be applied to the analysis of changes in the participation of sectors in national income, instead of to the analysis of changes in aggregates in absolute terms. Second, by means of a first-order approximation to Leontief's "open model", in which the price system is considered independent of the quantity system, we can distinguish in a simple way between real effects (derived from variations in factors considered at constant prices) and nominal effects (which result from changes in relative prices). These two methodological contributions are, to a certain extent, independent, since the first-order approximation to Leontief's ''open model'' could be used beyond the HSDA method.

3. METHODOLOGY

As aforementioned, the purpose of this work is to contribute to the dialogue around the greater or lesser relevance of various drivers of deindustrialization. We use input-output analysis to carry out a structural decomposition of the fall in the share of manufacturing in the GVA in these trends identified by the literature..The main objective of any decomposition analysis is to quantify which parts of the time variation of one variable can be attributed to the time variations of other variables, which are considered to be independent factors of the former. Thus, we start from the expression of a variable z as a product of a set of n factors $x_1, x_2, \dots, x_n$:

$$z = x_1 x_2 \ \dots x_n$$

So that the time difference of the variable z between an initial time t_0 and a final time t_1 can be expressed as:

$$\Delta z = x_1(t_1)x_2(t_1) \dots . x_n(t_1) - x_1(t_0)x_2(t_0) \dots . x_n(t_0) \qquad (1)$$

And considering that each factor can vary while the remaining factors remain constant (*ceteris paribus*), the objective is to express the value of Δz as the sum of the respective effects of each determinant x_i:

$$\Delta z = Effect\,\Delta x_1 + Effect\,\Delta x_2 + \dots + Effect\,\Delta x_n \qquad (2)$$

However, the way in which expression (2) can be derived from (1) is not unique, but consists of $n!$ different possibilities, all of them mathematically equally valid and exact. This is the so-called "non-uniqueness problem" (Dietzenbacher and Los, 1998). When faced with this problem, it is possible to adopt (in the manner of a pragmatic solution) the calculation of the arithmetic mean of the $n!$ possible solutions, which is itself an exact solution. However, this compromise solution presents at least two problems:

1. First, although all possible decompositions make mathematical sense, not all of them make theoretical sense. This is the so-called "relevance problem" (Chen and Wu, 2008; Kohler and Stehrer, 2009).

2. Secondly, if between the final instant t_1 and the initial instant t_0 there is a relatively long period of time, then the possible decompositions of (1) imply an assumed path for each independent variable that does not always correspond to the effective path, and this introduces a bias in the weighting of the different effects. This is the so-called "path problem" (Fernández-Vázquez *et al*., 2008).

To solve these two problems, different techniques have been developed that, in the end, have given rise to the method known as "dynamic-hierarchical structural decomposition" (Chen and Wu, 2008; De Boer, 2008; Koller and Stehrer, 2009, 2010). This method solves the indicated problems in two complementary ways:

1. To solve the "relevance problem", a method of decomposition is proposed whereby the total number of determinants is structured in such a way that they enter the total expression of z in a manner well defined by an assumed theoretical model. In this way, by introducing a hierarchy between the determinants, the consideration of theoretically insignificant decompositions is avoided, meanwhile reducing the number of calculations necessary.

2. To solve the "path problem", it is proposed that the expression (2) be obtained as if it were the result of integrating a differential:

$$\Delta z = \int_{t_0}^{t_1} \frac{dz}{dt}\,dt = \sum_{i=t_0+1}^{t_1} z(i) - z(i-1)$$
$$= \sum_{i=t_0+1}^{t_1} Effect\,[x_1(i) - x_1(i-1)] + \dots + Effect\,[x_n(i) - x_n(i-1)]$$

In this way, taking into account the accumulated contribution of each effect, the weight of each of the effects on the total variation of z is determined by its actual path.[6]

This method can be applied to study the determinants of the variation in the share of manufacturing in GVA (or GDP at factor cost); which, to the best of our knowledge, has not been done in previous research, Indeed, if we denote manufacturing GVA as y_{man} and total GVA as Y, then the share of manufacturing in GVA can be expressed as:

$$s = \frac{y_{man}}{Y}$$

[6] This solution to the "path problem" is possible only in the event that data is available for all of the time intervals that make up the period under study. Otherwise, econometric techniques must be used (Fernández Vázquez *et al*., 2008).

Taking this definition into account, and according to (1), the variation in the share of the manufacturing GVA in the total GVA can be expressed as:

$$\Delta s = \sum_{i=t_0+1}^{t_1} \left(\frac{y_{man}(i)}{Y(i)} - \frac{y_{man}(i-1)}{Y(i-1)} \right)$$

This expression, in turn, can be rewritten as:

$$\Delta s = \sum_{i=t_0+1}^{t_1} \left(\frac{\Delta y_{man}(i) - \Delta Y(i) \frac{y_{man}(i-1)}{Y(i-1)}}{Y(i)} \right) \qquad (3)$$

Where:

$$\Delta \mathrm{Y}\ (\mathrm{i}) = Y(i) - Y(i-1)$$
$$\Delta y_{man}(i) = y_{man}(i) - y_{man}(i-1)$$

Thus, according to (3), if it were possible to obtain, for each of the time intervals, Δy_{man} and ΔY as the sum of the effects of the variation of its components according to (2), then its accumulated contribution can be calculated as Δs. To this end, we arrive at the fundamental equation of the so-called Leontief's open model:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A} + \mathbf{N})^{-1}(\mathbf{d} + \mathbf{e} - \mathbf{m}) \qquad (4)$$

Where $\mathbf{x}$ is the gross output vector, $\mathbf{A}$ is the matrix of coefficients of total intermediate consumption (also called matrix of ''technical coefficients'') , $\mathbf{N}$ is the matrix of coefficients of imported intermediate consumption , $\mathbf{d}$ is the vector of final domestic demand, $\mathbf{e}$ is the export demand vector, and $\mathbf{m}$ is the final import demand vector. From this identity, and given a vector of added value per unit of output $\mathbf{v}$, total GVA or GDP at factor cost can be expressed as:

$$Y = \mathbf{v}^{\mathbf{T}}(\mathbf{I} - \mathbf{A} + \mathbf{N})^{-1}(\mathbf{d} + \mathbf{e} - \mathbf{m}) \qquad (5)$$

In turn, the transposed vector $\mathbf{v}^{\mathbf{T}}$ can be expressed as the surplus of each sector's turnout over its operating costs (consisting of intermediate consumption, taxes less subsidies on products, etc.) per unit of output, so that:

$$\mathbf{v}^{\mathbf{T}} = \mathbf{e}^{\mathbf{T}}\left(\mathbf{I} - \mathbf{A} - \hat{\mathbf{t}} - \widehat{\mathbf{m}}\right)$$

Where $\mathbf{t}$ is a vector of taxes less subsidies on products per unit of output and $\mathbf{m}$ is a vector of international transport margins per unit of output . As usual, the "hat" symbol above the vectors denotes their expression as diagonal matrices. In turn, the relationship between domestic demand and imports can be expressed as:

$$\mathbf{d} - \mathbf{m} = \hat{\mathbf{n}}\mathbf{d}$$

Where $\mathbf{n}$ is a final demand coverage rate vector. Finally, given a vector of prices $\mathbf{p}$ and assuming that the price system is independent of the quantity system[7] and that some form of the purchasing power parity

[7] This can only be the case if constant returns to scale prevail for all sectors and countries. Such assumption, despite being very restrictive, is typical of the open Leontief system (Miller, 2008, Ten Raa, 2005), hence of HSDA; and necessary for the assumption of independence between prices and quantities, and therefore for the introduction of prices in the decomposition analysis. Although it is an assumption that limits the explanations that can be given of the unequal role of prices in manufacturing sectors with respect to non-manufacturing sectors, we do not believe that the assumption of constant returns to

law applies[8], a matrix of coefficients of total intermediate consumption at constant prices $\tilde{\mathbf{A}}$ can be obtained, and a matrix of coefficients of imported intermediate consumption at constant prices $\tilde{\mathbf{N}}$, and, also, a vectors of domestic and foreign demand at constant prices $\tilde{\mathbf{d}}$ and $\tilde{\mathbf{e}}$, according to the following expressions:

$$\tilde{\mathbf{A}} = \hat{\mathbf{p}}^{-1}\mathbf{A}\hat{\mathbf{p}} \rightarrow \mathbf{A} = \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1}$$

$$\tilde{\mathbf{N}} = \hat{\mathbf{p}}^{-1}\mathbf{N}\hat{\mathbf{p}} \rightarrow \mathbf{N} = \hat{\mathbf{p}}\tilde{\mathbf{N}}\hat{\mathbf{p}}^{-1}$$

$$\tilde{\mathbf{d}} = \mathbf{d}\hat{\mathbf{p}}^{-1} \rightarrow \mathbf{d} = \hat{\mathbf{p}}\tilde{\mathbf{d}}$$

$$\tilde{\mathbf{e}} = \mathbf{e}\hat{\mathbf{p}}^{-1} \rightarrow \mathbf{e} = \hat{\mathbf{e}}\tilde{\mathbf{d}}$$

So that (4) can be expressed as:

$$Y = \mathbf{e}^{\mathbf{T}}\left(\mathbf{I} - \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} - \hat{\mathbf{t}} - \widehat{\mathbf{m}}\right)\left(\mathbf{I} - \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} + \hat{\mathbf{p}}\tilde{\mathbf{N}}\hat{\mathbf{p}}^{-1}\right)^{-1}\hat{\mathbf{p}}(\hat{\mathbf{n}}\tilde{\mathbf{d}} + \tilde{\mathbf{e}}) \qquad (6)$$

Similarly, given another vector $\mathbf{v_{man}}$ whose elements are identical to $\mathbf{v}$ in those rows that represent manufacturing sectors and identical to zero in the remaining rows, then the manufacturing GVA can also be expressed from (4) as:

$$y_{man} = \mathbf{v}_{\mathbf{man}}^{\mathbf{T}}(\mathbf{I} - \mathbf{A} + \mathbf{N})^{-1}(\mathbf{d} + \mathbf{e} - \mathbf{m}) \qquad (7)$$

In turn, the transposed vector $\mathbf{v}_{\mathbf{man}}^{\mathbf{T}}$ can be expressed as:

$$\mathbf{v}_{\mathbf{man}}^{\mathbf{T}} = \mathbf{e}^{\mathbf{T}}(\mathbf{J} - \mathbf{AJ} - (\hat{\mathbf{t}} + \widehat{\mathbf{m}})\mathbf{J})$$

Where $\mathbf{J}$ is a diagonal matrix whose elements are null for non-manufacturing sectors and equal to one for manufacturing sectors. Taking this equation into account, as well as the previous development that allowed the deduction of (6) from (5), then from (7) the following can be deduced:

$$y_{man} = \mathbf{e}^{\mathbf{T}}\left(\mathbf{J} - \hat{\mathbf{p}}\tilde{\mathbf{A}}\mathbf{J}\hat{\mathbf{p}}^{-1} - \hat{\mathbf{t}} - \widehat{\mathbf{m}}\right)\left(\mathbf{I} - \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} + \hat{\mathbf{p}}\tilde{\mathbf{N}}\hat{\mathbf{p}}^{-1}\right)^{-1}\hat{\mathbf{p}}(\hat{\mathbf{n}}\tilde{\mathbf{d}} + \tilde{\mathbf{e}}) \qquad (8)$$

Expressions (6) and (8) already allow us to identify all the relevant elements for the structural decomposition analysis, in such a way that they seem valid expressions to obtain (3) as the result of the accumulated contribution of each effect. However, these expressions are highly non-linear, making it difficult to obtain an expression like (2) from which to calculate (3). To overcome this difficulty, it is possible to make a first-order approximation of both expressions. So, considering the definition of the Leontief inverse as:

$$\left(\mathbf{I} - \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} + \hat{\mathbf{p}}\tilde{\mathbf{N}}\hat{\mathbf{p}}^{-1}\right)^{-1} = \sum_{\mathbf{k}=\mathbf{0}}^{\infty}\left(\hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} - \hat{\mathbf{p}}\tilde{\mathbf{N}}\hat{\mathbf{p}}^{-1}\right)^{\mathbf{k}} \qquad (9)$$

Then, if the series (9) exists, its terms must tend toward the null matrix $\mathbf{0}$, and, accordingly, the terms of second order, third order, etc., must contribute less and less to the determination of Y and y_{man}. Also, since the matrices $\tilde{\mathbf{A}}$ and $\tilde{\mathbf{N}}$ are made up of elements significantly smaller than one, it is to be assumed that its convergence is quite fast, and that a first-order approximation to (6) and (8) can be a good approximation, so that:

---

scale rules out the Baumol and Engel effects, at least in some of its formulations. The former can be deduced under the assumption of constant returns to scale and homothetic preferences, as the result of uneven productivity growth rates and similar wage growth rates in manufacturing and non-manufacturing sectors. Likewise, the latter can be deduced under the assumption of constant returns to scale and non-homothetic preferences, as the result of different income-elasticity of demand for manufactures and for non-manufactures.

[8] Note that, since we are concerned with the evolution of the aggregates, in order for this approximation to be reasonable, it is sufficient that the weak version of the purchasing power parity hypothesis be fulfilled for tradable goods and services exclusively (*i.e*. those that are included in exports and imports of the countries).

$$Y \sim Y^* = \mathbf{e}^{\mathbf{T}}\left(\mathbf{I} - \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} - \hat{\mathbf{t}} - \hat{\mathbf{m}}\right)\left(\mathbf{I} + \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} - \hat{\mathbf{p}}\tilde{\mathbf{N}}\hat{\mathbf{p}}^{-1}\right)\hat{\mathbf{p}}(\hat{\mathbf{n}}\tilde{\mathbf{d}} + \tilde{\mathbf{e}})$$

$$y_{man} \sim y^*_{man} = \mathbf{e}^{\mathbf{T}}\left(\mathbf{J} - \hat{\mathbf{p}}\tilde{\mathbf{A}}\mathbf{J}\hat{\mathbf{p}}^{-1} - (\hat{\mathbf{t}} + \hat{\mathbf{m}})\mathbf{J}\right)\left(\mathbf{I} + \hat{\mathbf{p}}\tilde{\mathbf{A}}\hat{\mathbf{p}}^{-1} - \hat{\mathbf{p}}\tilde{\mathbf{N}}\hat{\mathbf{p}}^{-1}\right)\hat{\mathbf{p}}(\hat{\mathbf{n}}\tilde{\mathbf{d}} + \tilde{\mathbf{e}})$$

For our sample, this first-order approximation represents no less than 73% of the actual value for all the aggregates, periods, and countries considered, the average being around 84% of the actual value. Such first-order approximations have the virtue of being able to be manipulated until reaching an expression like (2) that can be calculated directly, without incurring in numerical approximations. In effect, developing both approximations and applying the commutative property in the multiplication of diagonal matrices, these approximations can be expressed as the row sum of the product of two matrices and a vector:

$$Y^* = \mathbf{e}^{\mathbf{T}}\hat{\mathbf{p}}\tilde{\mathbf{H}}\tilde{\mathbf{f}} \qquad (10)$$

$$y^*_{man} = \mathbf{e}^{\mathbf{T}}\hat{\mathbf{p}}\tilde{\mathbf{H}}_{\boldsymbol{man}}\tilde{\mathbf{f}} \qquad (11)$$

where:

$$\tilde{\mathbf{H}} = \mathbf{I} - \tilde{\mathbf{N}} - \tilde{\mathbf{A}}\left(\tilde{\mathbf{A}} - \tilde{\mathbf{N}}\right) - (\hat{\mathbf{t}} + \hat{\mathbf{m}})\left(\mathbf{I} + \tilde{\mathbf{A}} - \tilde{\mathbf{N}}\right)$$

$$\tilde{\mathbf{H}}_{\mathbf{man}} = \mathbf{J} + \mathbf{J}\left(\tilde{\mathbf{A}} - \tilde{\mathbf{N}}\right) - \tilde{\mathbf{A}}\mathbf{J}\left(\mathbf{I} + \tilde{\mathbf{A}} - \tilde{\mathbf{N}}\right) - (\hat{\mathbf{t}} + \hat{\mathbf{m}})\mathbf{J}\left(\mathbf{I} + \tilde{\mathbf{A}} - \tilde{\mathbf{N}}\right)$$

$$\hat{\mathbf{f}} = \hat{\mathbf{n}}\tilde{\mathbf{d}} + \tilde{\mathbf{e}}$$

In this way, expressions (10) and (11) represent a first-order approximation of the total GVA and the manufacturing GVA as the row sum of the product of a diagonalized vector of prices $\mathbf{p}$, a pair of input-output coefficient matrices at constant prices $\tilde{\mathbf{H}}$ and $\tilde{\mathbf{H}}_{\mathbf{man}}$, and a vector of final demand at constant prices $\mathbf{f}$. Thus, by means of a first-order approximation such as this, it is possible to clearly distinguish between real and nominal factors, explicitly considering in the analysis the role that prices may have played in the variation of manufacturing share. In fact, from such approximations, it is possible to obtain an expression analogous to (3) reflecting the variation in the share of the first-order components of manufacturing GVA in the first-order components of total GVA:

$$\Delta s^* = \sum_{i=t_0+1}^{t_1} \left(\frac{\Delta y^*_{man}(i) - \Delta Y^*(i)\dfrac{y^*_{man}(i-1)}{Y^*(i-1)}}{Y^*(i)} \right) \qquad (12)$$

Considering that $y^*_{man}(i) = \beta(i)y_{man}(i)$ and $Y^*(t) = \alpha(i)Y(i)$, where α and β are parameters that represent the ratio of the first-order components to their actual value in each period i, the previous expression can be rewritten as:

$$\Delta s^* = \sum_{i=t_0+1}^{t_1} \left(\frac{(\beta(i)y_{man}(i) - \beta(i-1)y_{man}(i-1)) - (\alpha(i)Y(i) - \alpha(i-1)Y(i-1))\dfrac{\beta(i-1)y_{man}(i-1)}{\alpha(i-1)Y(i-1)}}{\alpha(i)Y(i)} \right)$$

So, if $\alpha(i) \approx \alpha(i-1)$, $\beta(i) \approx \beta(i-1)$, and $\frac{\beta(i)}{\alpha(i)} \approx 1$, then expression (12) would be a good approximation to (3). Fortunately, this is the case for our sample, being the variation between two contiguous periods of the ratios $\alpha(i)$ and $\beta(i)$ less than 3% of their value for all the countries and years of the sample, and below 1% for almost all cases, and being the ratio $\frac{\beta(i)}{\alpha(i)}$ greater than 0.89 for all the countries and years of the sample, and close to 1 with less than a decimal of difference for almost all cases.

The virtue of approximation (12) is that, from expressions (10) and (11), it is now possible to apply the HSDA method in a relatively simple and direct way. Indeed, taking into account expressions (10) and (11), two decompositions can be obtained:

$$\Delta Y^*(i) = Effect_Y\, \mathbf{\Delta p}(i) + Effect_Y\, \mathbf{\Delta \tilde{A}}(i) + Effect_Y\, \mathbf{\Delta \tilde{N}}(i) + Effect_Y\, \mathbf{\Delta t}(i) + Effect_Y\, \mathbf{\Delta m}(i) + Effect_Y\, \mathbf{\Delta n}(i) + Effect_Y\, \mathbf{\Delta \tilde{d}}(i) + Effect_Y\, \mathbf{\Delta \tilde{e}}\,(i) \quad (13)$$

$$\Delta y^*_{\mathrm{man}}(i) = Effect_{y_{man}}\, \mathbf{\Delta p}(i) + Effect_{y_{man}}\, \mathbf{\Delta \tilde{A}}(i) + Effect_{y_{man}}\, \mathbf{\Delta \tilde{N}}(i) + Effect_{y_{man}}\, \mathbf{\Delta t}(i) + Effect_{y_{man}}\, \mathbf{\Delta m}(i) + Effect_{y_{man}}\, \mathbf{\Delta n}(i) + Effect_{y_{man}}\, \mathbf{\Delta \tilde{d}}(i) + Effect_{y_{man}}\, \mathbf{\Delta \tilde{e}}\,(i) \quad (14)$$

Where, in order to avoid the "relevance problem", each of the effects can be calculated according to the following hierarchical structure given by our own linear approach:

Diagram 1. Hierarchical decomposition

Value added at basic prices (total and manufacturing)

$$Y^* = \mathbf{e}^{\mathbf{T}}\mathbf{\hat{p}}\mathbf{\tilde{H}}\mathbf{\tilde{f}}$$

$$y^*_{man} = \mathbf{e}^{\mathbf{T}}\mathbf{\hat{p}}\mathbf{\tilde{H}}_{\boldsymbol{man}}\mathbf{\tilde{f}}$$

Prices

$\mathbf{\hat{p}}$

Input-Output coefficients at constant prices

$$\mathbf{\tilde{H}} = \mathbf{I} - \mathbf{\tilde{N}} - \mathbf{\tilde{A}}(\mathbf{\tilde{A}} - \mathbf{\tilde{N}}) - (\mathbf{\hat{t}} + \mathbf{\hat{m}})(\mathbf{I} + \mathbf{\tilde{A}} - \mathbf{\tilde{N}})$$

$$\mathbf{\tilde{H}_{man}} = \mathbf{J} + \mathbf{J}(\mathbf{\tilde{A}} - \mathbf{\tilde{N}}) - \mathbf{\tilde{A}}\mathbf{J}(\mathbf{I} + \mathbf{\tilde{A}} - \mathbf{\tilde{N}}) - (\mathbf{\hat{t}} + \mathbf{\hat{m}})\mathbf{J}(\mathbf{I} + \mathbf{\tilde{A}} - \mathbf{\tilde{N}})$$

Taxes less subsidies on products $\mathbf{\hat{t}}$

International transport margins $\mathbf{\hat{m}}$

Imported intermediate consumption $\mathbf{\tilde{N}}$

Total intermediate consumption $\mathbf{\tilde{A}}$

Final demand at constant prices

$$\mathbf{\hat{f}} = \mathbf{\hat{n}}\mathbf{\tilde{d}} + \mathbf{\tilde{e}}$$

Coverage rates $\mathbf{\hat{n}}$

Domestic demand $\mathbf{\tilde{d}}$

Foreign demand $\mathbf{\tilde{e}}$

This hierarchical decomposition results from the first-order approximations (10) and (11) and represents added value as a result of the interaction of three elements: final prices, inputs used and final demand. Thus, the composition of final demand at constant prices determines the real output of each sector, but added value results from valuing this output at their actual prices after taking into account the inputs used and produced by each sector. Thus, this hierarchy reflects the intuition that added value is the surplus that each sector obtains over its turnout given a set of prices and given a production technology (in that case represented by the input-output coefficients). And, in this sense, it can better show the need to carry out a first-order approximation of the Leontief inverse matrix, since such approximation allows us to easily introduce the role of prices in determining added value as a factor separate from the structure of inputs.

Taking this hierarchical structure into account, and in order to avoid the "problem of non-uniqueness", the average of all those exact decompositions that are compatible with such structure is calculated for each of the periods considered.[9] From here, the variation of the participation of manufacturing in the total GVA can be calculated as the accumulated contribution of the effects due to the variation of each of the determinants plus a residual term, resulting from the difference between the actual variation in each period and the variation of the first-order terms of the Leontief's "open model":

[9] For details of the HSDA computation method, see Koller and Stehrer (2009).

$$\Delta s = \sum_{i=t_0+1}^{t_1} \big(Effect\ \mathbf{\Delta p}\ (i) + Effect\ \mathbf{\Delta \tilde{A}}(i) + Effect\ \mathbf{\Delta \tilde{N}}(i) + Effect\ \mathbf{\Delta t}(i) + Effect\ \mathbf{\Delta m}(i) + Effect\ \mathbf{\Delta n}(i) + Effect\ \mathbf{\Delta \tilde{d}}(i) + Effect\ \mathbf{\Delta \tilde{e}}\ (i) + Res(i)\big) \tag{15}$$

Where each of the effects is calculated from (3), so that, for example:

$$Effect\ \mathbf{\Delta p}(\mathrm{i}) = \frac{Effect_{y_{man}}\ \mathbf{\Delta p}(i) - Effect_Y\ \mathbf{\Delta p}(i)\dfrac{y_{man}(i-1)}{Y(i-1)}}{Y(i)}$$

And the remaining effects are computed in the same way. So in order to summarize the information obtained through our decomposition analysis according to the topics mentioned, we add the effects into four categories:

- The "price effect", which is equivalent to the effect of the variation of the prices vector.
$$Price\ effect = Effect\ \mathbf{\Delta p}$$
- The "domestic demand effect", which is equivalent to the effect of the variation of the domestic demand vector at constant prices.
$$Domestic\ demand\ effect = Effect\ \mathbf{\Delta \tilde{d}}$$
- The "technology effect", which is equivalent to the effect of the variation of the matrix of technical coefficients at constant prices.
$$Technology\ effect = Effect\ \mathbf{\Delta \tilde{A}}$$
- The "external trade effect", which is equivalent to the effect of the variation of the coverage rate vector plus the variation of the vector of imported input matrices, plus the variation of the vector of the international distribution margins, plus the effect of the variation of the external demand vector. This effect can therefore be broken down into two effects: the "import" and "export" effects (the latter including only the effect of the variation in the external demand vector):
$$External\ insertion\ effect = Effect\ \mathbf{\Delta n} + Effect\ \mathbf{\Delta \tilde{N}} + Effect\ \mathbf{\Delta m} + Effect\ \mathbf{\Delta \tilde{e}}$$
- The "residual effect", which is equivalent to residuals themselves, i.e., the difference between the actual variation and the variation due to the first-order terms of Leontief's model, plus the effect of the variation of the vector of taxes less subsidies on products per unit of output[10]:
$$Residual\ effects = Effect\ \boldsymbol{\Delta t} + Residuals$$

4. RESULTS AND DISCUSSION

Our results will be presented as follows: first, we show two non-trade effects we have found to be dominant (prices and domestic demand); second, we discuss the case of the technology effect, which appears to have a secondary influence; third, we analyze the import and export effects, as well as their net effect (that is, the external trade effect).

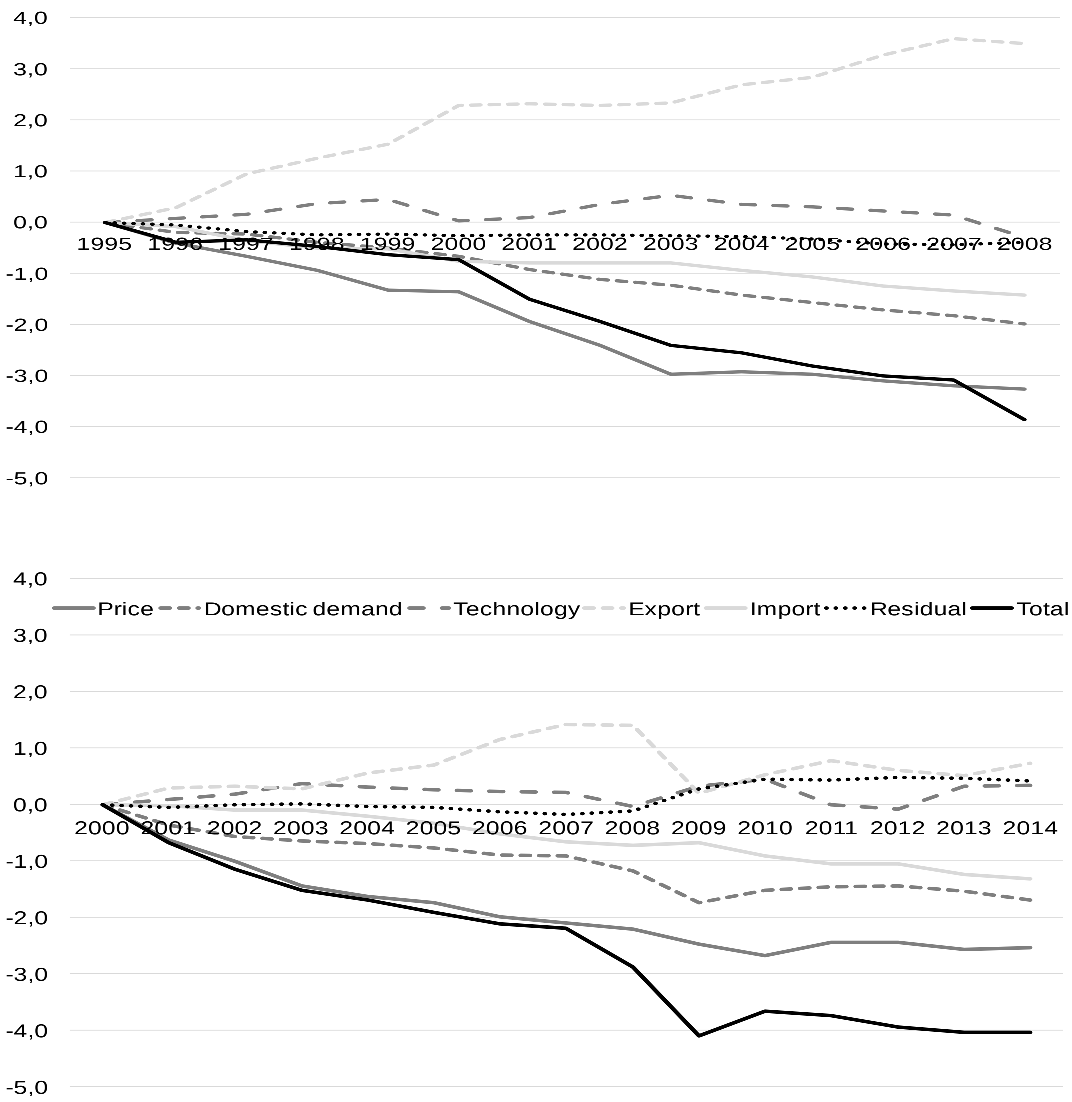
We organize the results in this manner in order to facilitate the discussion around the debates that were presented in Section 2: the Baumolian thesis would appear in what we here call the price effect, whereas the Engel-derived postulates would be observable in our domestic demand effect. In turn, changes in the

[10] The effect of taxes less subsidies, despite being an independent factor like the others, was included within the "residual effect" because, in general, it is so small that it is negligible.

composition of inputs (as in the servitization hypothesis) are assessed through the technology effect; and globalization-related deindustrialization would be seen in the external trade effect.

The following comments on all of these effects generally refer to the averages corresponding to each data series (R13 and R16), once Korea and Taiwan have been eliminated (Figure 1). However, where applicable, we indicate the most notable differences between periods or countries. Detailed data by periods and by countries are collected in Table 2.

Figure 1. The five effects on the variation of the participation of manufactures in the GVA (in percentage points), OECD-13 average, 1995-2008 (R13) and 2000-2014 (R16), respectively



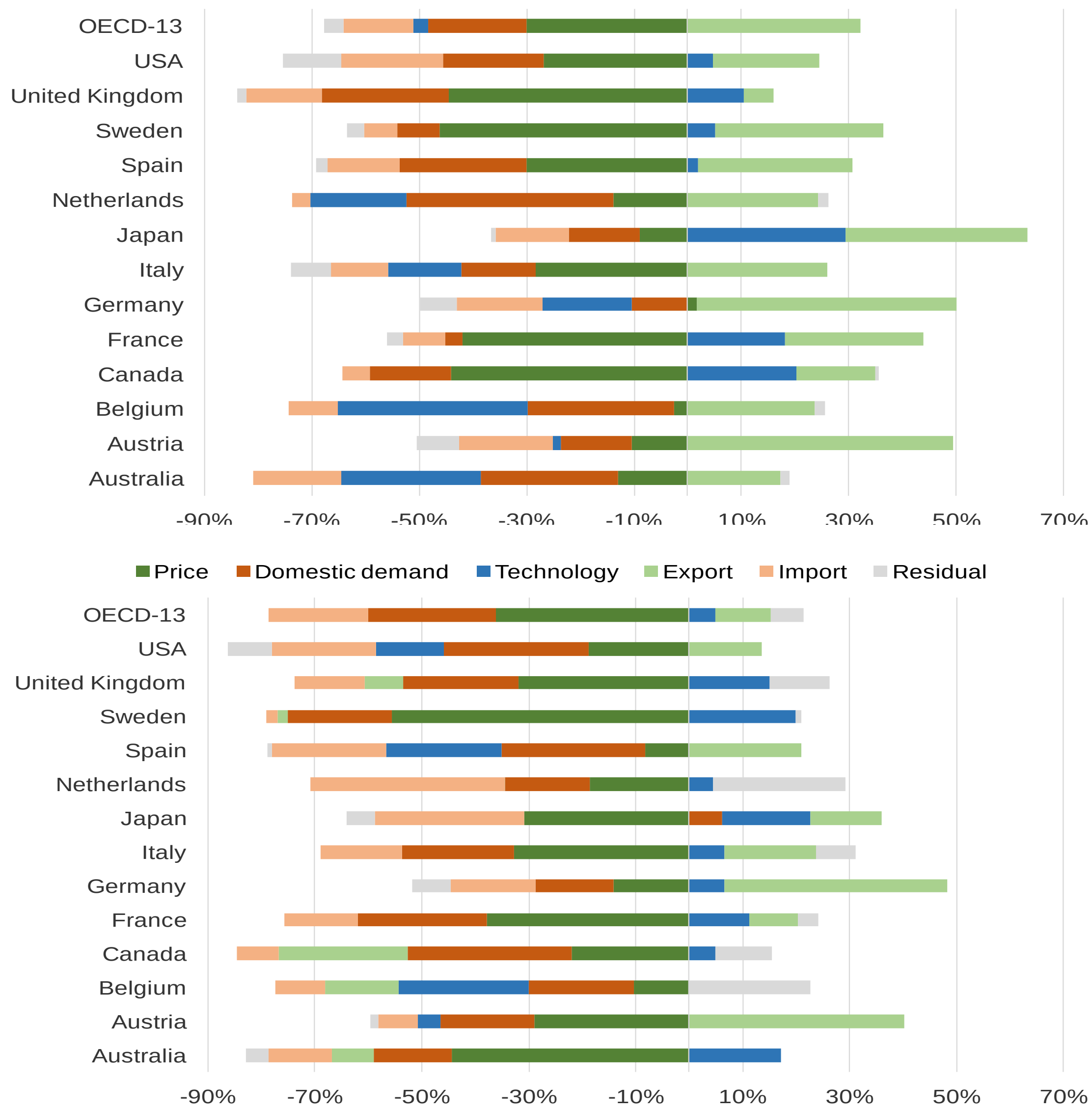
Source: Own elaboration with WIOD data (R13 and R16).

Dominant non-trade effects: prices and domestic demand

The price effect and the domestic demand effect are among the most important effects studied. Specifically, the downward pressure exerted on the participation of manufactures in the GVA of the OECD-13 (variable at around -4 percentage points in both R13 and R16) was especially pronounced by way of changes in prices and domestic demand. These two combined effects amounted to -5.3 points in R13 and -4.2 points in R16 (Figure 1, Table 2).

In any case, the price effect was clearly greater than the effect of domestic demand on the loss of participation by manufacturing (Figure 1), which would emphasize the fundamental nature of Baumol's hypothesis. In percentage points, the price effect was around one point stronger than the domestic demand effect (-3.3 vs. -2.0 in R13, -2.5 vs. -1.7 in R16). Furthermore, if instead of considering the effects in percentage points, we consider the contribution of each to the sum of the five effects (in absolute values), we observe that the price effect contributes one of the largest portions of that total: 30% in R13 (second behind exports) and no less than 36.1% in R16 (the largest of the five effects). Domestic demand, for its part, played a more modest role in the years before the 2008 crisis (18.4% of the total effects in R13) and became more pronounced (although below that of prices) in the period that includes the years following the crisis (24% in R16) (Figure 2).

Figure 2. Contribution of each effect to the sum of all effects on the variation in the participation of manufactures in the GVA (in %), 1995-2008 (R13) and 2000-2014 (R16), respectively



Source: Own elaboration with WIOD data (R13 and R16).

If we examine the data by country, we find that the effects of prices and domestic demand are almost always negative, as with the OECD-13 as a group;[11] although the behavior of the price variable is less homogeneous (standard deviations of 3.1 in R13 and of 1.6 in R16) than that of domestic demand (standard deviation of 0.8 in both Releases) (Table 2).

Table 2. The effects on the variation of the participation of manufactures in the GVA (in percentage points), 1995-2008 (R13) and 2000-2014 (R16), right and left boxes respectively

	Price	Domestic demand	Technology	Exports	Imports	TOTAL	Price	Domestic demand	Technology	Exports	Imports	TOTAL
Australia	-0.9	-1.7	-1.8	1.2	-1.1	-4.2	-3.6	-1.2	1.4	-0.6	-1.0	-5.4
Austria	-1.7	-2.1	-0.2	7.9	-2.8	-0.2	-3.1	-1.9	-0.4	4.3	-0.8	-2.1
Belgium	-0.3	-2.7	-3.6	2.4	-0.9	-4.9	-1.1	-2.1	-2.6	-1.4	-1.0	-5.8
Canada	-7.2	-2.5	3.3	2.4	-0.8	-4.7	-1.7	-2.4	0.4	-1.9	-0.6	-5.4
France	-8.2	-0.6	3.5	5.0	-1.5	-2.4	-3.3	-2.1	1.0	0.8	-1.2	-4.5
Germany	0.3	-1.7	-2.7	7.9	-2.6	0.0	-1.4	-1.5	0.7	4.2	-1.6	-0.4
Italy	-2.4	-1.2	-1.2	2.2	-0.9	-4.1	-3.6	-2.3	0.7	1.9	-1.7	-4.1
Japan	-0.9	-1.3	-2.8	3.2	-1.3	-3.1	-2.6	0.5	1.4	1.1	-2.3	-2.3
Korea	-10.4	-5.6	2.7	14.0	-0.5	1.0	-11.0	-3.9	6.1	11.0	-1.2	1.3
Netherlands	-1.1	-3.0	-1.4	1.9	-0.3	-3.7	-1.4	-1.2	0.3	0.0	-2.8	-3.2
Spain	-3.7	-2.9	0.2	3.5	-1.6	-4.7	-0.6	-2.1	-1.7	1.7	-1.7	-4.6
Sweden	-8.0	-1.3	0.9	5.4	-1.1	-4.7	-6.4	-2.2	2.3	-0.2	-0.2	-6.6
Taiwan	-13.7	-6.0	4.8	14.2	-2.5	-4.1	-10.1	1.3	4.5	9.1	0.2	4.2
UK	-6.3	-3.4	1.5	0.8	-2.0	-9.6	-3.4	-2.3	1.6	-0.8	-1.4	-5.0
USA	-2.1	-1.5	0.4	1.5	-1.5	-3.9	-0.8	-1.1	-0.5	0.6	-0.8	-3.0
OCDE-15	-4.4	-2.5	0.2	4.9	-1.4	-3.6	-3.6	-1.6	1.0	2.0	-1.2	-3.1
Std Dev	4.1	1.5	2.5	4.2	0.7	2.5	3.2	1.2	2.2	3.7	0.7	2.9
OCDE-13	-3.3	-2.0	-0.3	3.5	-1.4	-3.9	-2.5	-1.7	0.3	0.7	-1.3	-4.0
Std Dev	3.1	0.8	2.2	2.4	0.7	2.4	1.6	0.8	1.4	1.9	0.7	1.8

Source: Own elaboration with WIOD data (R13 and R16).

The irregularity of the technology effect

Regarding the technology effect (in reference to the hypothesis of servitization, which seeks to explain deindustrialization based on the increasing incorporation of services as intermediate goods into manufactures), the results from both Releases speak of a very limited effect, negative in R13 (-0.3) and positive in R16 (0.3). The contribution of the technology effect to the sum of the five effects (in absolute values) proved very modest (2.7% and 4.9% in R13 and R16, respectively) although this was due to significant variability in the different countries. Indeed, looking at the technology effect by country, we find that (unlike with the other effects) no common pattern emerged with respect to the sign, which was positive in six countries (out of 13) in 2000-2008 (R13) and in ten in 2000-2014 (R16), with non-negligible standard deviations of 2.2 and 1.4, respectively.

These results (minimal technology effects and positive signs in some countries) do not firmly support what the servitization hypothesis posits. Without further research, we can suggest that this could be due to the fact that the servitization literature does not distinguish between the real effect due to variations in

[11] The only exceptions here are prices for Germany in R13 and demand for Japan in R16 (Table 2), with minimal variations.

the quantities of inputs and the nominal effects due to variations in relative prices. Given the inflationary behavior of services, servitization might occur even without an actual increase in the relative quantity of services used as inputs. Considering only quantities of inputs, it could be that some sectors do experiment servitization, but others experiment "manufacturization". The combination of these two trends might aid in explaining small technology effects, as well as either downward or upward pressures on manufacturing shares.

The import and export effects

Next, and before completing our analysis with the overall external trade effect, we examine the import and export effects separately.

The import effect – which considers the import penetration of manufactures as a driving factor of deindustrialization – is relatively little studied (most works interested in this aspect have focused on the impact on employment and/or on exclusively on the import penetration of inputs).[12] Our results show that, indeed, imports (like prices and domestic demand) put downward pressure on the manufacturing GVA, with declines of between one and one and a half points (-1.4 points in R13 and -1.3 points in R16) (Figure 1 and Table 2). In terms of the contribution of the import effect to the total effects, this proved moderate but not negligible: 13.1% and 18.6% in R13 and R16, respectively (or slightly over five percentage points below the weights of the domestic demand effect).

Taking the countries separately, the import effect was always negative (as for the OECD-13 as a whole) and notably homogeneous, showing the smallest standard deviation among the five variables under study (at 0.7 for both data series). It can thus be concluded that behind the deindustrialization process, there is a biased propensity of imports toward manufacturing (of inputs and aggregate final goods), although not in a singular or decisive way.

Regarding the export effect, in the years prior to the 2008 crisis, this served forcefully as the main compensation mechanism for the other effects (acting, in other words, as a brake on deindustrialization dynamics, with an effect of 4.9 in R13); but this clearly decreased over the period that includes data from after the crisis (ultimately reaching 0.7 in R16) (Figure 1, Table 2). Similarly, when observing the contribution of the export effect to the total of effects, we found it to be the largest in R13, representing no less than 35.4% of the total, while in R16 it fell to 10.4%, below even the effects of imports or domestic demand.

Considering the data by country, the positive variation in exports observed for the OECD-13 as a whole likewise occurs for each of the countries studied in the period prior to the crisis (R13). Thus, without the positive contribution of the export effect, the loss of participation of manufactures in the GVA during the period prior to the 2008 crisis would have been much greater than that registered. On the other hand, in the period that includes the years following the crisis (R16), the sign of the export effect is heterogeneous, becoming negative in five of the 13 countries studied. In both series, the standard

[12] Most of the works that provide evidence on the impact of offshoring in more mature economies do so only in consideration of the impact on industrial employment (Amiti and Wei, 2009; Burke *et al*., 2011; Autor *et al*., 2013; among others), with little research seeking to elucidate the effect of offshoring on the evolution and composition of the GVA (Baldwin, 2019). The analyses on trade in value added (TiVA) confirm the loss or substitution of domestic value added for imported value added in the production of final goods (Baldwin and López-González, 2015; De Backer and Miroudot, 2013). However, the objective of these works is not to evaluate the impact of this substitution effect on the evolution of industrial added value, but rather the differential between gross exports and the added value generated by these within the country, and therefore they do not offer complete and systematic information that would includes, for example, the increase in the use of imported goods in the production of final goods oriented toward the domestic market, or the substitution of imports for final products.

deviation is indeed considerable, highlighting the variability in the intensity of the export effect (at 2.4 in R13 and at 1.9 in R16) (Table 2).

More concretely, Germany and Austria (and to an even greater extent, outside the OECD-13, Korea and Taiwan) presented very dynamic export demand; and this dynamism is key to explaining their avoidance of decreases in the participation of manufactures in GVA. In the opposite direction, Australia and the United Kingdom saw particularly sharp falls in the participation of manufacturing (of 8 and 10 points, respectively), due not only to the high negative contributions of most other components but (probably most distinctively) due to the scant positive contribution of external demand.

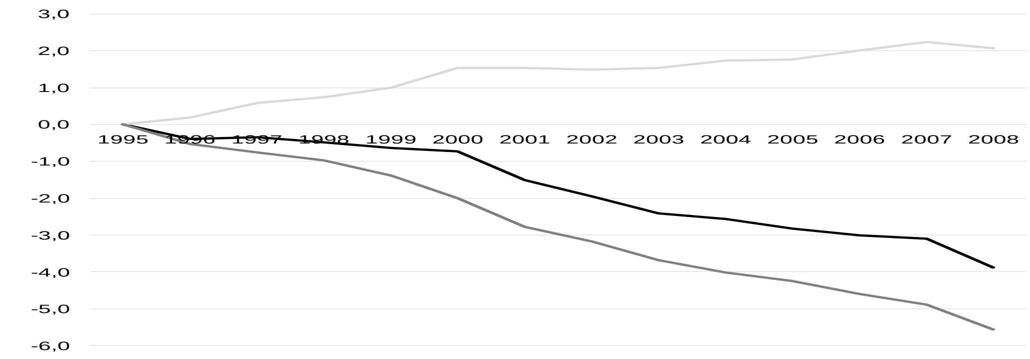
The external trade effects and its relevance compared to the non-trade effects

Recall that external trade effects are among those debated in the literature, which tends to attribute it a negative sign: that is to say, globalization (via imports of manufactures and the offshoring of manufacturing) is thought to push deindustrialization (see Section 2). In fact, the external trade effects (or the sum of imports and exports) was initially and markedly positive (at 2.1 in R13), although this collapsed to the point of changing its sign when data including the years after the 2008 crisis were incorporated (falling to -0.6 in R16) (Figure 3). Thus, we can conclude that globalization had a "positive"[13] effect on the participation of manufacturing in the GVA – at least until the slowdown in global trade after 2008. This finding in some way contradicts hypotheses suggesting that external trade has acted as a factor of deindustrialization since the globalizing boom of the 1990s.

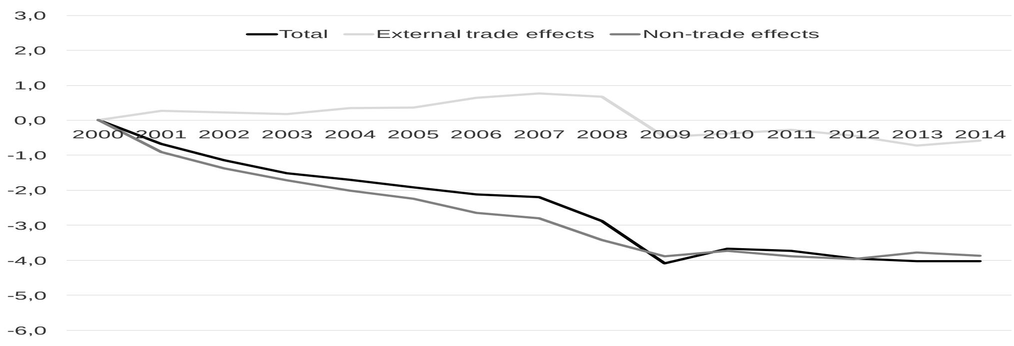
Compared to the external trade effects, the non-trade effects (the sum of the effects on prices, domestic demand, and technology) behaved much more consistently throughout the overall period, clearly lowering the participation of manufacturing in the GVA, with the combined non-trade effects amounting to -5.6 and -3.9 in R13 and R16, respectively.

If we look at the total aggregate effects, the respective contributions of external trade and non-trade effects exhibit considerable differences between the two WIOD Releases, precisely because of this drop in external effects. In R13, the contribution of external factors was slightly higher than that of non-trade factors (52.1% vs. 51.1%), but when data from the years after the 2008 crisis are included, as in R16, the contribution to the total globalization effect amounts to slightly less than half that of the combined non-trade effects (29.0% vs. 65.0%) (Figure 2).

Figure 3. Trade and non-trade effects on the variation of the participation of manufactures in the GVA (in percentage points), OECD-13, 1995-2008 (R13) and 2000-2014 (R16), respectively



[13] "Positive" strictly refers to an observed positive export effect (an upward push on the share of manufacturing in GVA) larger than the observed negative import effect (a downward push). It does not relate to whether countries have trade surpluses or deficits. In fact, in the period to which we are referring to (1995-2008) we find positive external trade effects among countries with both surpluses (e.g. Germany) and deficits (e.g. Spain).

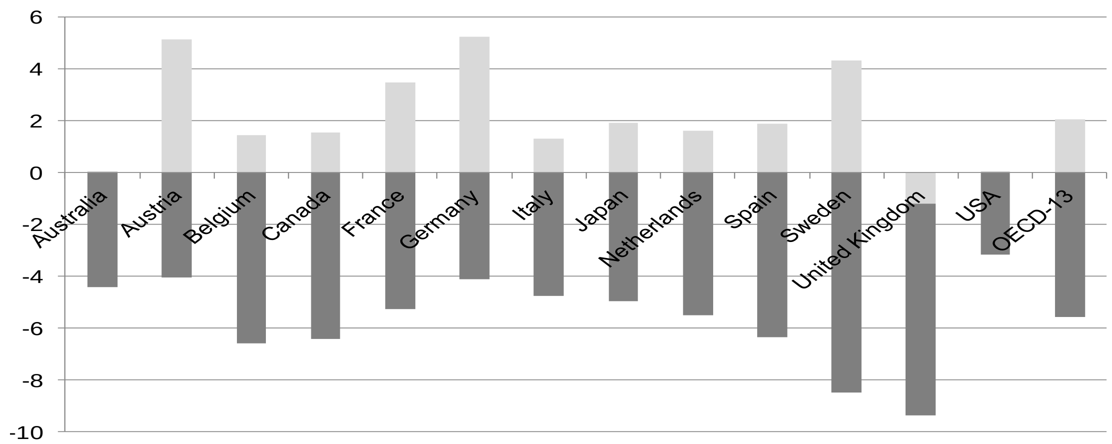


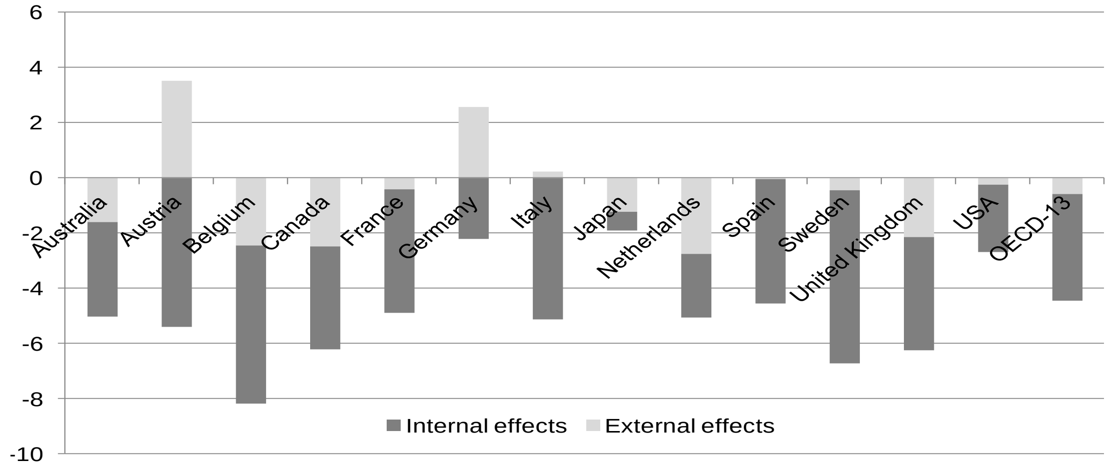
Source: Own elaboration with WIOD data (R13 and R16).

By country, the signs and intensities of the external and non-trade effects are confirmed, although some notable differences emerge (Figure 4). In R13, which includes the period prior to the crisis (1995-2008), the contribution of external components (external trade effects) was positive in all countries except the United Kingdom. At the opposite extreme are Germany and Austria (with external trade effects of 5.3 and 5.1 points, respectively), while in the remaining countries the effect was positive but well below four percentage points. On the other hand, in R16 (2000-2014, including years following the crisis) the effect of external trade was null or negative in all countries except Germany and Austria, where effects remained positive and not insignificant (at 2.6 and 3.5, respectively).

The contribution of non-trade effects examined by country was more consistent than that of external effects: it was negative in all countries and according to both data series (R13 and R16). More specifically, in almost all countries, the non-trade effects meant reductions in the participation of manufactures in the GVA ranging between three and six percentage points (with somewhat higher values in R13 than in R16, generally speaking). Very few countries deviated from these values in either edition of the data: extreme cases included the United Kingdom (-8.2) and Sweden (-8.5) in R13, with particularly strong effects from non-trade components, and Japan (-0.7) in R16, with a particularly weak effect.

Figure 4. Trade and non-trade effects on the variation in the participation of manufactures in the GVA (in percentage points), by country and OECD-13, 1995-2008 (R13) and 2000-2014 (R16), respectively





Source: Own elaboration with WIOD data (R13 and R16).

Finally, Figures 5 and 6 explore the correlation between the external and non-trade effects, respectively, and the fall in the participation of manufacturing in the GVA.

The relationship between the non-trade effects and that decline is clearly seen, thanks to the elimination of Korea and Taiwan from the sample (Figure 6); but the relationship between the external trade effects and the variation in the participation of manufactures in the GVA is no less clear.

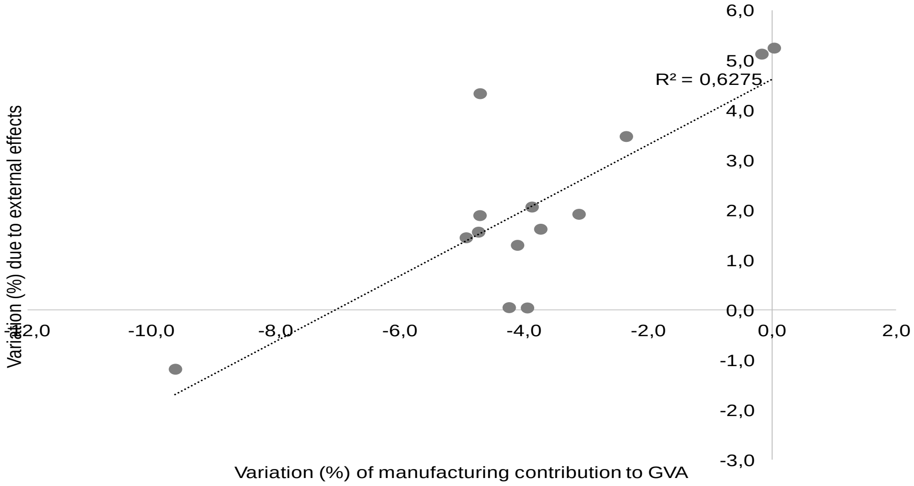
Those countries (Germany and Austria)[14] in which the contribution of external factors was abnormally positive were precisely the countries where the participation of manufactures in the GVA suffered only scant setbacks throughout the study period. Likewise, the only country in which the external trade effects were negative in both R13 and R16 – the United Kingdom – also registered the largest drop in the participation of manufacturing.

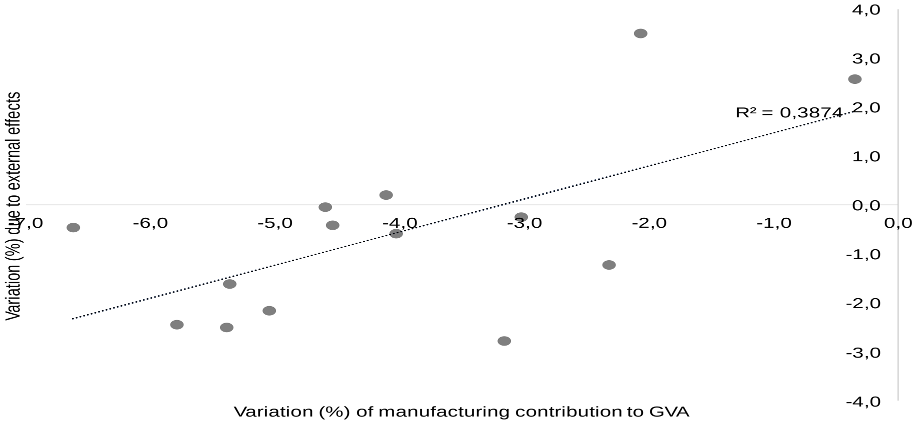
Considered by way of periods, most countries in the pre-crisis period (R13) lost more than 3.5 points of participation by manufacturing, despite the positive contributions of external factors; in the period encompassing the years after the crisis (R16), those countries that lost five or more points of participation by manufacturing did so, at least in part, due to the negative contribution of the external trade effects.

Therefore, these results taken together demonstrate not only the relevance of external components (despite the scarce attention these have received in the literature), but also that their influence has evolved over time, from clearly positive in the pre-crisis period to mostly negative in the post-crisis period.

Figure 5. Relationship between external trade effects and variations in the share of manufacturing in the GVA, by country, 1995-2008 (R13) and 2000-2014 (R16), respectively

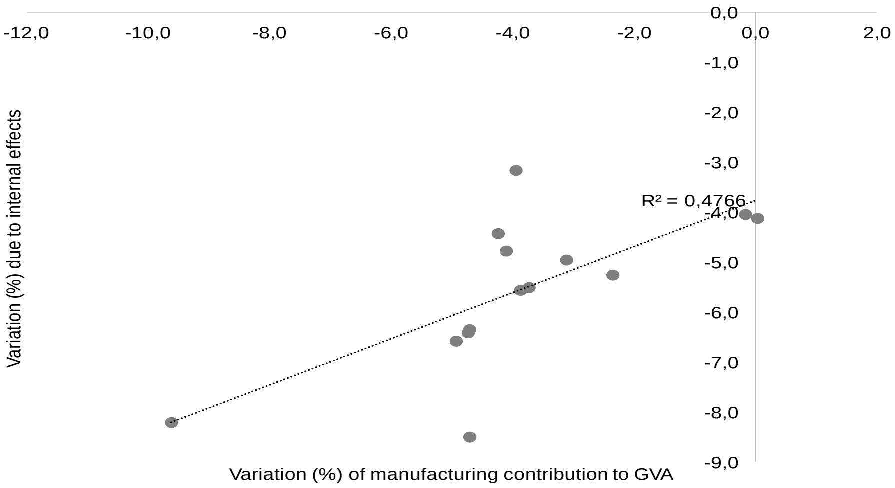
[14] The inclusion of Taiwan and Korea in the sample would suppose an even clearer inverse correlation, as the GVA of these countries has remained abnormally high, due precisely to an unusually intense globalization effect.

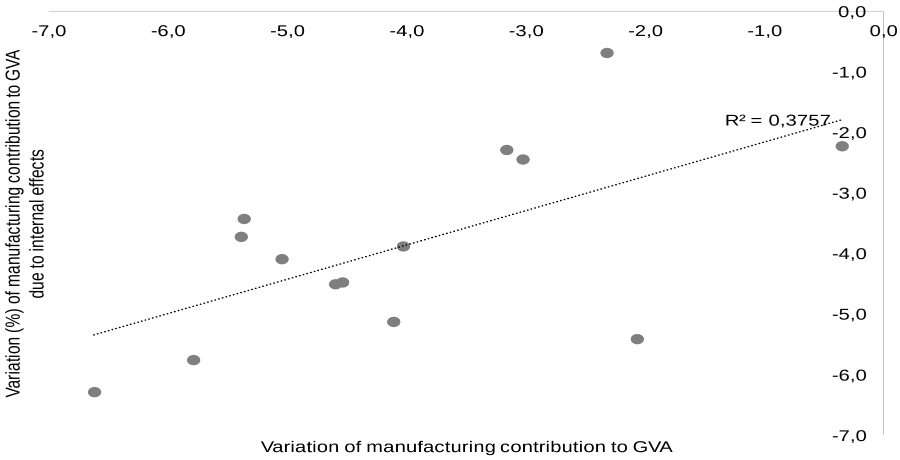




Source: Own elaboration with WIOD data (R13 and R16).

Figure 6. Relationship between non-trade effects and variations in the share of manufacturing in the GVA, by country, 1995-2008 (R13) and 2000-2014 (R16), respectively





Source: Own elaboration with WIOD data (R13 and R16).

6. CONCLUSIONS

In this work, using data from input-output tables and applying a dynamic-HSDA method, we have undertaken a decomposition of the variation of the participation of manufacturing in the GVA in mature economies. We have grouped components by virtue of drivers present in the specialized literature on deindustrialization for this type of economy, enabling us to observe the quantitative contributions of their different effects: the price effect, the domestic demand effect, the technology effect, and the external trade effect (broken in turn into import and export effects).

Our central conclusion is that these quantified effects present similar trends and weights in most of the countries analyzed. Therefore, we find a series of empirical regularities in the industrialization dynamics that affect mature economies. More concretely:

(a) The price and domestic demand effects have a decisive influence, although the price effect is somewhat more dominant than the domestic demand effect. The technology effect, meanwhile, is less regular both by country and over time than those of price or domestic demand.
(b) Deindustrialization can be explained not only by the above factors but also by the process of substitution of domestic production by imported products (import effect).
(c) Export demand acts as the main offset for the other effects, able to operate as a brake on the dynamics of deindustrialization (especially true for the period prior to the 2008 crisis).
(d) As a result of (b) and (c) external trade as a whole likewise acts, in general, as a mechanism to brake deindustrialization, although its positive contribution has tended to decrease over time, becoming negative after the crisis of 2008.

Although (as stated) one central conclusion is that these empirical regularities do occur, two issues must be qualified. In terms of particular countries, some unique cases emerge. In Germany and Austria (and in Korea and Taiwan), where the participation of manufactures did not decline (or did so very moderately), the external trade effects played a particularly prominent compensatory role; these four countries along with Japan were the only ones presenting positive trade balances throughout the period under study. On the other hand, in the United Kingdom and Australia, the loss of participation of manufactures was especially intense, partly (and precisely) due to the scant or null positive contributions of the export effect in these countries.

As to periods, the trends observed since the crisis (2009-2014) do not present the consistency observed in the two series consulted in this work. The data to be offered by the subsequent series (not yet published) may allow us to test the scope of the results obtained in this work in a future investigation.

The relevance of this research lies in part in its empirical approach, which permits the overcoming of approaches that refer to a single factor as the main determinant, as well as approaches that rely on dichotomous questions (supply vs. demand; non-trade-related changes vs. external trade). Our joint analysis, executed through application of the dynamic HSDA method for a representative set of highly industrialized economies, has permitted the quantification of all the stated effects together. And the main corollary of our results is in fact that they have allowed us to verify that the loss of participation by manufactures in the GVA is, in effect, the result of a sum of several trends, almost all of which move in the same direction.

This corollary is close to that of those authors (Herrendorf *et al*, 2013; Iscan, 2010) who attribute structural change to a combination of the Baumolian and Engelian thesis (here, price and domestic demand effects). However, our results suggest that those postulates should be further completed with globalization-related effects (as seen in our external trade effects) in line with Matsuyama (2009, 2017). Indeed, in contrast to the importance traditionally given to non-trade factors, our results underline the role of imports as a secondary but steady driver of deindustrialization, as well as the role of exports as a decisive offset of that trend. Jointly, imports and exports seem to contribute oppositely to Krugman's hypothesis about the negative influence of globalization on the participation of manufacturing in GVA.

Finally, it must be reminded that, despite the fact that most theoretical contributions on the negative implications of deindustrialization for growth refer to the importance of the participation of manufactures in added value, many works that try to explain deindustrialization in mature economies do so from the perspective of employment. Thus, the present contribution to the study of drivers of deindustrialization, understood through the lens of the GVA, may be of assistance in the search for solutions in terms of industrial policy (back in the agendas of a large part of the countries studied). In this sense, the work shows the relevance of the price effect and the domestic demand effect, which are difficult to alter through industrial policies. But it also reveals the importance of other effects such as the import effect and, very especially, the export effect or, to a lesser extent, the technological effect, on which industrial policy can exert an influence. For instance, in certain countries (Germany, Japan, Korea, Taiwan), where the export effect has been particularly helpful in compensating other forces pushing towards deindustrialization, industrial policies have probably aided in explaining said export-orientation.

In any case, in order to make this method and its preliminary results more useful in terms of policy, future research focused on national cases will be necessary. That is, by using the same data and the same dynamic HSDA methodology, specific trajectories of deindustrialization could be described in greater detail. For example, studies could differentiate periods based on the recent economic history of the country in question, perhaps further disaggregating the domestic demand effect into a domestic consumption effect and an investment effect; or else differences could be examined by productive sectors, where certain major effects may be more prominent in some than in others. To this respect, the same exercise could be done distinguishing between "progressive" sectors on the one hand and "traditional" sectors of the economy on the other ("progressive" and "traditional" in terms of productivity growth). That would allow us to test whether there is a decline in the share of the former, and to then analyze its drivers.

REFERENCES

Almon, M. and Tang, J. (2011): “Industrial Structural Change and the Post-2000 Output and Productivity Growth Slowdown: A Canada-US Comparison”, *International productivity Monitor*, 22, Fall.

Alvarez-Cuadrado, F., Long, N., and Poschke, M. (2017): “Capital-Labor Substitution, Structural Change, and Growth“, *Theoretical Economics*, 12:3, September.

Amiti, M. and Wei, Sh. (2009): “Does Service Offshoring Lead to Job Losses? Evidence from the United States“, International Trade in Services and Intangibles in the Era of Globalization, *NBER Studies in Income and Wealth*, Vol. 69. Chicago and London: University of Chicago Press.

Angeriz, A., McCombie, J., and Roberts, M. (2008): “New Estimates of Returns to Scale and Spatial Spillovers for EU Regional Manufacturing, 1986-2002“, *International Regional Science Review*, 31:1, January.

Autor, D.H, Dorn, D., and Hanson, G.H. (2013): “The China Syndrome: Local Labor Markets Effects of Import Competition in the United States”, *American Economic Review*, 103:6.

Baldwin, R. (2019): “GCV Journeys: Industrialization and Deindustrialization in the Age of the Second Unbundling”, *Journal of the Japanese and International Economies*, 52, June.

Baldwin, R. and López-González, J. (2015): “Supply-Chain Trade: A Portrait of Global Patterns and Several Testable Hypotheses“, *World Economy*, 38:11, November.

Baldwin, R., Forslid, R., and Ito, T. (2015): “Unveiling the Evolving Forces of Value Added in Exports, *Joint Research Program Series*, No. 161, Institute of Developing Economies, IDE-JETRO, March.

Baumol W. (1967): “Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis”, *American Economic Review*, 57:3.

Baumol, W., Blackman, S., and Wolff, E.N. (1985): “Unbalanced Growth Revisited: Asymptotic Stagnancy and New Evidence”, *American Economic Review*, 75 (4).

Berlingeri, G. and Marcolin, L. (2018): “Export Dynamics and the Sourcing ofSservice Inputs, Developments in Global Sourcing”, *Cesifo Seminar Series,* MIT Press.

Boulhol, H. and Fontagne, L. (2006): “Deindustrialisation and the Fear of Relocations in the Industry“, *Working Paper*, CEPII Research Center.

Buera, F. and Kaboski, J. (2009): “Can Traditional Theories of Structural Change Fit the Data?”, *Journal of the European Economic Association*, 7:2-3, 469-477, April-May.

Burke, J., Epstein, G., and Oh, S.Y. (2011): “Outsourcing, Demand and Employment Loss in U.S. Manufacturing, 1990-2005“, *Working Paper*, Political Economy Research Institute, University of Massachusetts at Amherst.

Chen, Y., and Wu, J. (2008): “Simple Keynesian Input-Output Structural Decomposition Analysis Using Weighted Shapley Value Resolution”, *Annals of Regional Science*, 42.

Clark, C. (1951): *The Conditions of Economic Progress*, London: MacMillan.

Comín, D., Lashkari, D., and Mestieri, M. (2017): “Structural Change with Long-Run Income and Price Effects“, *Discussion Papers*, No.12458, CEPR.

Crozet, M and Milet, E. (2017): “Should Everybody Be in Services? The Effect of Servitizaertion on Manufacturing Firm Performance”, *Journal of Economics and Management Strategy*, 26:820-841.

Cuadrado-Roura, J. and Maroto, A. (2016): “Unbalanced Regional Resilience to the Economic Crisis in Spain: A Tale of Specialisation and Productivity“, *Cambridge Journal of Regions, Economy and Society*, 9:1, March.

De Backer, K. and Miroudot, S. (2013): “Mapping Global Value Chains”, *OECD Trade Policy Papers*, No. 159.

De Boer, P. (2008): “Additive Structural Decomposition Analysis and Index Number Theory: An Empirical Application of the Montgomery Decomposition“, *Economic Systems Research*, 20:1, March.

De Haan, M. (2001): “A Structural Decomposition Analysis of Pollution in the Netherlands”, *Economic Systems Research*, 13:2.

Dietzenbacher, E. and Los, B. (1998): “Structural Decomposition Techniques: Sense and Sensivity”, *Economic Systems Research*, 10:4.

Di Meglio, G., Gallego, J., Maroto, A., and Savona, M. (2018): “Services in Developing Economies: The Deindustrialization Debate in Perspective“, *Development and Change*, 49:6, November.

Djellal, F. and Gallouj, F. (2008): *Measuring and Improving Productivity in Services: Issues, Strategies and Challenges*, Services, Economy and Innovation Series, Cheltenham, U.K. and Northampton, Mass.: Edward Elgar.

Duarte, M. and Restuccia, D. (2017): “Relative Prices and Sectoral Productivity”, *Working Paper* No. 23979, NBER.

Duarte, M. and Restuccia, D. (2007): “The Role of the Structural Transformation in Aggregate Productivity“, *Working Paper*, Department of Economics, University of Toronto.

Duernecker, G., Herrendorf, B. and Valentiny, A. (2017): “Structural Change within the Service Sector and the Future of Baumol’s Disease”, *Discussion Paper* No. DP1246, CEPR.

Felipe, J., Aashish, M., and Changyong, R. (2019): “Manufacturing Matters…But it’s the Jobs that Count”, *Cambridge Journal of Economics*, 43.

Fernández-Vázquez, E., Los, B., and Ramos-Carvajal, C. (2008): “Using Additional Information in Structural Decomposition Analysis: The Path-Based Approach” *Economic Systems Research*, 20:4.

Gadrey J. (2003): *Socio-économie des services*, Paris: La Decouverte.

Herrendorf, B., Herrington, Ch., and Valentinyi, A. (2015): “Sectoral Technology and Structural transformation”, *American Economic Review: Macroeconomics*, 7:4.

Herrendorf, B., Rogerson, R., and Valentiny, A. (2013): “Two Perspectives on Preferences and Structural Transformation”, *American Economic Review*, 103:7.

Inklaar, R. and Timmer, M. (2014): “The Relative Price of Services“, *Review of Income and Wealth*, 60:4, December.

Iscan, T. (2010): “How Much Can Engel’s Law and Baumol’s Disease Explain the Rise of Service Employment in the United States?”, *B.E Journal of Macroeconomics*, 10:1, January.

Jorgenson, D. and Timmer, M. (2011): “Structural Change in Advanced Nations: A New Set of Stylised Facts“, *Scandinavian Journal of Economics*, 113:1, March.

Kaldor, N. (1966): “Marginal Productivity and the Macro-Economic Theories of Distribution: Comment on Samuelson and Modigliani“, *Review of Economic Studies*, 33.

Kelle, M. (2013): “Crossing industry borders: German Manufacturers as Services Exporters”, *World Economy*, 36:12.

Koller, W., and Stehrer, R. (2009): “Trade Integration, Outsourcing and Employment in Austria: A Decomposition Approach”, *Working Paper* No. 56, WIIW.

Koller, W. and Stehrer, R. (2010): “Trade Integration, Outsourcing and Employment in Austria: A Decomposition Approach“, *Economic Systems Research*, 22:3, September.

Kowalkowski, Ch., Gebauer, H., Kamp, B., and Parry, G. (2017): “Servitization and deservitization: Overview, concepts, and definitions”, *Industrial Marketing Management*, 60.

Krugman, P. (1996): “Domestic Distortion and the Deindustrialization Hypothesis”, *Working Paper* No. 5473, NBER.

Kucera, D. and Milberg, W. (2003): “Deindustrialization and Changes in Manufacturing Trade: Factor Content Calculations for 1978-1995“, *Review of World Economics*, 139:4.

Matsuyama, K. (2009): “Structural Change in an Interdependent World: A Global View of Manufacturing Decline”, *Journal of the European Economic Association*, 7:2-3, April-May.

Matsuyama, K. (2017): “Engel's Law in the Global Economy: Demand-induced Patterns of Structural Change, Innovation, and Trade”, *Discussion Paper* No. 12387, CEPR.

McCombie, J. (1982): “Economic Growth, Kaldor’s Laws and the Static-Dynamic Verdoorn Law Paradox“, *Applied Economics*, 14:3, June.

Millemaci, E. and Ofria, F. (2014): “Kaldor-Verdoorn’s Law and Increasing Returns to Scale: A Comparison across Developed Countries“, *Journal of Economic Studies*, 41:1.

Miller, R..E. and Blair, P.D. (2009): *Input-Output Analysis: Foundations and Extensions* (2nd Edition), New York: Cambridge University Press.

Ngai, L., and Pissarides, C. (2007): “Structural Change in a Multisector Model of Growth”, *American Economic Review*, 97:1.

Nordhaus, W. (2008): “Baumol’s Diseases: A Macroeconomic Perspective“, *B.E. Journal of Macroeconomics: Contributions to Macroeconomics*, 8:1.

Pieper, U. (2003): “Sectoral Regularities of Productivity Growth in Developing Countries--A Kaldorian Interpretation“, *Cambridge Journal of Economics*, 27:6, November.

Rowthorn, R. and Ramaswamy, R. (1999): “Growth, Trade and Deindustrialisation”, *Staff Papers*, 46:1, IMF.

Savona M. y Lorentz, A. (2006): “Demand and Technology Determinants of Structural Change and Tertiarisation: An Input-Output Structural Decomposition Analysis for four OECD Countries”, BETA, *Document de travail* 2006-01, CNTS, ULP.

Schreyer, P. (2001): "The OECD Productivity Manual: A Guide to the Measurement of Industry-Level and Aggregate Productivity", *International Productivity Monitor*, 2, Spring.

Ten Raa, T. (2009): *The Economics of Input-Output Analysis*, New York: Cambridge University Press.

Tregenna, F. (2014): "A New Theoretical Analysis of Deindustrialisation", Cambridge Journal of Economics, 38:6, November.

Triplett, J. and Bosworth, K. (2003): "Baumol's Disease Has Been Cured. IT and Multifactor Productivity in US Service Industries", presented at the *Brookings Workshop on Service Industry Productivity*, Brookings Institution, September, Washington DC.

Van Neuss, L. (2018): "Globalization and Deindustrialization in Advanced Countries", *Structural Change and Economic Dynamics*, 45, June.

THE DRIVERS OF DEINDUSTRIALIZATION IN ADVANCED ECONOMIES: A HIERARCHICAL STRUCTURAL DECOMPOSITION ANALYSIS

Pablo R. Liboreiro[a]
Rafael Fernández[b]
Clara García[c]

[a] Universidad Politécnica de Madrid
ETSI Caminos, Canales y Puertos
C/ Profesor Aranguren 3
28040 Madrid (Spain)

[b, c] Complutense Institute for International Studies
Universidad Complutense de Madrid
Finca Mas Ferré, Edificio A
Campus de Somosaguas, Entrada 3
Pozuelo de Alarcón, 28223 Madrid (Spain)

Corresponding author: Clara García
clgarcia@ucm.es
Calle Santa Cruz de Marcenado 10, 4º Derecha, 28015 Madrid (Spain)

Declarations of interest: none.